INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 15, No. 4, p. 80-85, 2019
http://www.innspub.net

REVIEW PAPER OPEN ACCESS

Applications of DNA barcoding and future directions

Maryam Pakiza[*1], Syed Naeem Sajid[2], Asim Hussain[1], Salman Maqsood[1], Usman Imtiaz[3], Haris Ali[4], Saif Ur Rehman[4], Sayyad Hammad Mahboob[2], Sidra Ray[2], Arzoo Rubab[2], Sadia Zafar[2]

[1]*Department of Biochemistry, University of Agriculture, Faisalabad, Pakistan*

[2]*Centre of Agricultural Biochemistry and Biotechnology, University of Agriculture, Faisalabad, Pakistan*

[3]*Department of Biochemistry, Government College University, Faisalabad, Pakistan*

[4]*Department of Applied Chemistry, Government College University, Faisalabad, Pakistan*

Article published on October 30, 2019

Key words: Phytomedicinals, DNA barcoding, NGS, Super-barcodes, Authentication, Ethno-genetics

Abstract

DNA barcoding help to recognize the plant based on short, gene sequences in a rapid, accurate, and cost effective manner. Current focus is on the investigation of phytomedicinals and herbal product integrity and authenticity through DNA barcoding with the goal of protecting consumers from potential health risks associated with product substitution and contamination. Recent reports reveal that DNA barcoding can be used for the assignment of unknown specimens to a taxonomic group, authentic identification of phytomedicinals, and in plant biodiversity conservation. Research indicates that there is no single universal barcode candidate for identification of all plant groups. Hence, comparative analysis of plant barcode loci is essential for choosing a best candidate for authenticating particular medicinal plant genus/families. Currently, both chloroplast/nuclear regions are used as universal barcodes for the authentication of phytomedicinals. A recent advance in genomics has further enhanced the progress in DNA barcoding of plants by the introduction of high-throughput techniques like next generation sequencing, which has paved the way for complete plastome sequencing that is now termed as super-barcodes. Hence, current focus is on the investigation of phytomedicinals and herbal product integrity and authenticity through DNA barcoding with the goal of protecting consumers from potential health risks associated with product substitution and contamination. These approaches could improve the traditional ethno-botanical and scientific knowledge of phytomedicinals and their safe use.

***Corresponding Author:** Maryam Pakiza ✉ maryampakiza07@gmail.com

Introduction

DNA barcodes are primarily used to identify the species over the tree of life (Kress *et al.*, 2012). DNA barcoding facilitates to flag which are potentially new to science as a biodiversity discovery tool such as cryptic species (Hebert *et al.*, 2004). DNA barcoding provides away for identification of regulated species, invasive species and enlarged species for the practical user of taxonomy. It also plays a vital role in identification and purification of botanical products like as commercial, herbal and dietary supplements. DNA barcodings are being used to handle ecological, evolutionary and conservation issues in these days such as ecological gathering of species in plant communities (Kress *et al.*, 2008). The grade of ecological civilization present in plant and animal channel and settle the most evolutionary distinct habitats for safety (Shapcott *et al.*, 2015).

DNA barcoding is a method of species identification using a short section of DNA from a specific gene or genes. The premise of DNA barcoding is that, by comparison with a reference library of such DNA sections also called "sequences", an individual sequence can be used to uniquely identify an organism to species, in the same way as a supermarket scanner uses the familiar black stripes of the UPC barcode to identify an item in its stock against its reference database. These "barcodes" are sometimes used in an effort to identify unknown species, parts of an organism, or simply to catalog as many taxa as possible, or to compare with traditional taxonomy in an effort to determine species boundaries (Chase *et al.*, 2005).

DNA barcoding is a technique that is used to identify the species based on species-specific differences in short regions of their DNA. DNA barcoding uses state-of-the-art biotechnology to identify plant species in a rapid, accurate, and cost-effective manner. This technique is not restricted by morphological characteristics, physiological conditions, and allows species identification without specialist taxonomic knowledge. This has made researchers to use DNA barcoding technique to evaluate the herbal product authenticity.

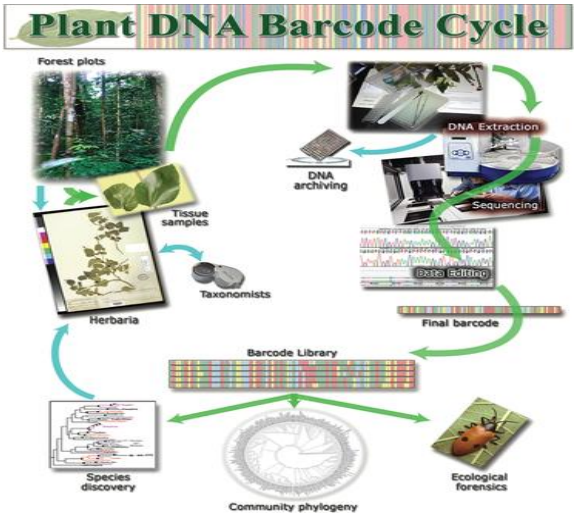

Fig. 1. DNA barcoding life cycle.

Applications of DNA barcoding

Now a days it is common to observe the publication testing system many labels in specific group of plants. Eventually before universal plant marker were selected systematizes, ecologists, evolutionary biologists and conservationists were before assuming and giving starting tests of the application of plant DNA barcodes to negotiate captious questions in organism biology (Valentini *et al.*, 2009).

Identification of Species and their Communities Phylogeny

DNA barcodes have massively extended the concert between systematics who core on species identifications and evolutionary relationships and ecologist who examine species relationships and ways of association as a tool (Baker *et al.*, 2017). Plant DNA barcodings provide assist to community ecologists searching to judge the factors such as species diversity pools and functional characters which control the gathering of species into ecological communities (Swenson, 2012). Phylomatic, A tool of assessing phylogenetic trees for plant communities was a great step for ecologists (Webb *et al.*, 2005). DNA barcodes separately cannot deliver specific new discernment into the work of working traits in finding plant species assemblages. However the sequencing data gives enough signed to run phylogenetic hypothesis on the work of evolutionary signal in gathering species. It was hoped that the combination of character and phylogeny would permit the final to

be a strong forecast in measuring characters similarities which species unfortunately the association between phylogeny and working traits is not always a direct correlation thereby protecting phylogenetic signs from being a proxy for ecological similarity (Swenson *et al.*, 2013).

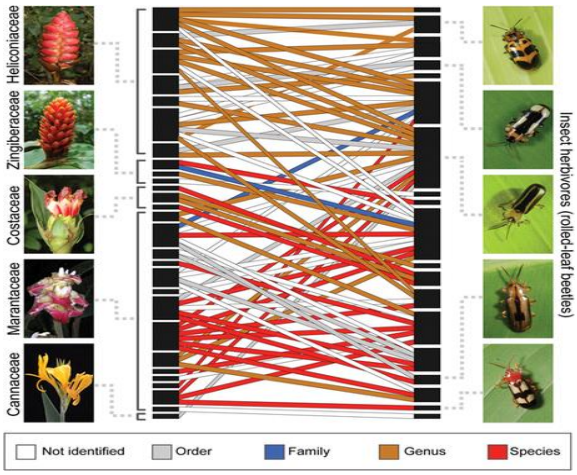

Fig. 2. Identification of Species and their Communities.

In one of broad study in tropical forests, examined and compared 17 functional traits in 668 species within a forest plot in The Northern Amazon region using 2 DNA barcode marker (Baraloto *et al.*, 2012). They searched that functional similarity was higher than phylogenetic similarity in co-existing species and that two factors were important in finding niche overlap. They close out that environmental filtering had the highest influence on finding how tree species are gathered in these tropical communities (Swenson *et al.*, 2012).

The distribution of underground roots as determined by plant DNA barcodes. Map from Barro Colorado Island in Panama of the projected distribution of roots of four species in the top 20 cm of soil. The root sampling points at which roots of the focal species were found are indicated with stars, with size scaled to the frequency of the species in proportion mass of samples genotyped. The root sampling points at which no roots of the focal species were found are indicated by open diamonds. The color shows the expected root density of the focal species under a best fit model, with red indicating the highest value, yellow intermediate, and white lowest.

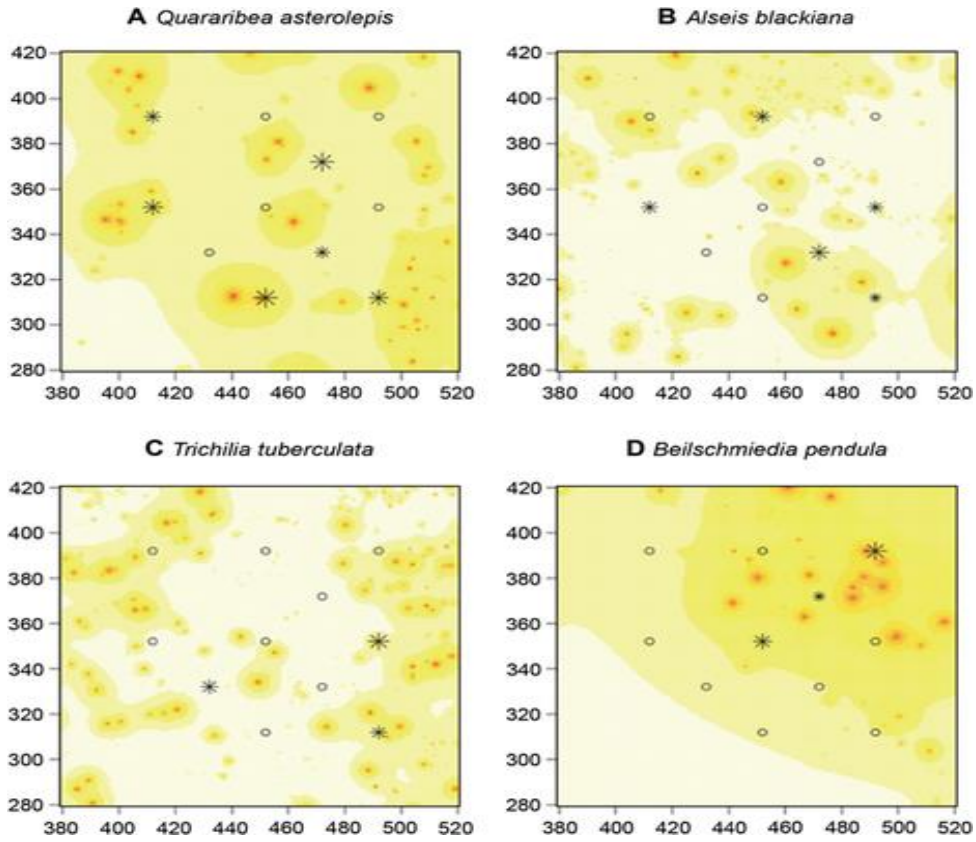

Fig. 3. The distribution of underground roots as determined by plant DNA barcodes.

Interactions of species

For the complete understanding of the ecology and evolution of relationships between species in natural and human changed environment, precise and renewal identification combining partners are directive. The development of DNA barcodes being specie stage marker has already start to revolutionize our thinking's about species interaction have developed.

DNA barcodes in Forensics

The accurate identification of plants and animal is equally important in commercial world as it in non-scientific, commercial world as it is to ecologist and taxonomist the accurate identification of plants and animals is equally important. Cancer among women has become a serious public health problem especially breast cancer leads to development of abnormal tissues and metastasis occurs (Naeem et al.,2019) Timber is not only commercial plant product in necessary of correct identifications by controller and quality regulators. Conventional medicines teas, and herbal supplements combine are a beneficial products and huge part of conventional market in biodiversity, locally, nationally and internationally. Inclusive examination of the certified herbal supplements.

DNA barcodes library Construction

Finally DNA barcodes sequence data (rbcL, matK, and TrnH-psbA) were created and compared within 15 forest plots in the CTFS/Forest GEO network representing 1347 species of tree in both temperate and tropical environment in seven different countries (Kress *et al.*, 2008).

New sequencing technologies

Chance and forecasting on upcoming direction of plant DNA barcoding start approximately with the beginning of studies implementing these markers to contest in taxonomy, evolution, and ecology, involving the relationship within locus based DNA barcodes and genomics close to species identification (Erickson *et al.*, 2014). The search for both latest sequencing technologies as well as productive database design and search strategies for species identification were recognized.

Functional traits and species

Like explained above for examinations of communities phylogenetic histories, ecologist have been long interested in quantifying critical plant characters which permit species work in specific environment and accordingly collect into communities. Measuring the degree of similarity of characters in an assemblage gives insight into those characters that permit species to co-occur or not. Quantitative information's on functional traits collectively with well granite evolutionary histories find ecologist, a powerful tool for understanding the way of community collection (Swenson, 2012).

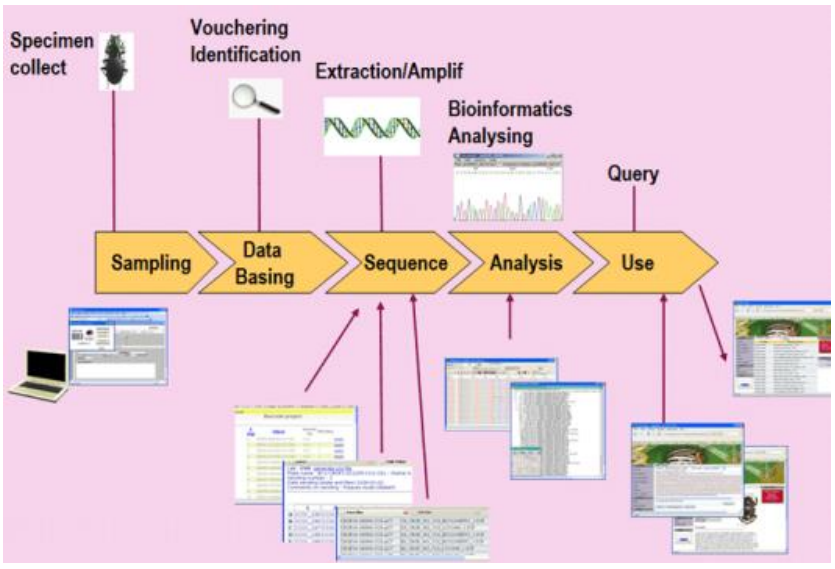

Fig. 4. DNA barcodes library Construction.

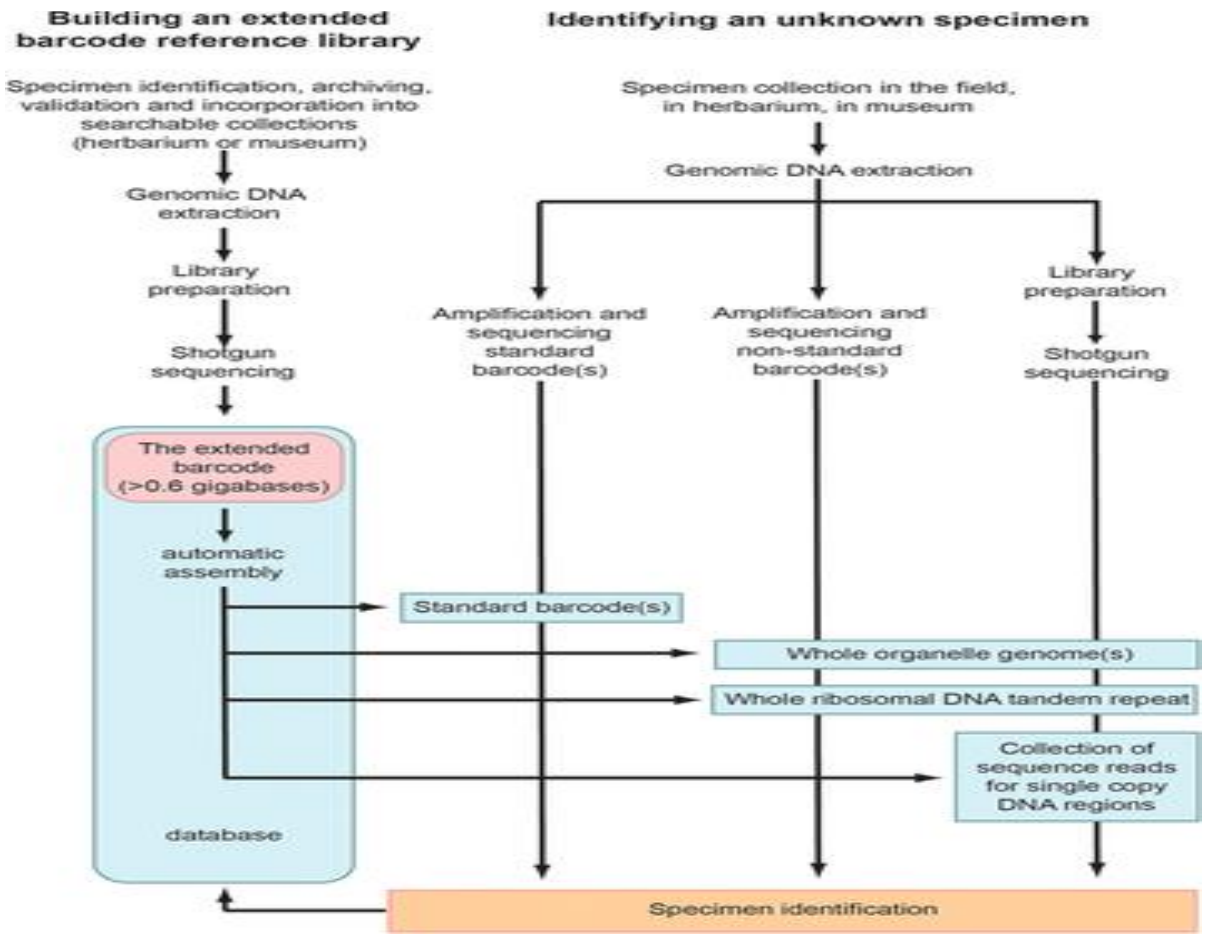

Fig. 5. Library Extension and Specimen Identification.

Conclusion

There is more need to understand the extension in DNA barcoding with special reference barcode for identification of species and their interaction. Then identification of organism makes easy by using the barcode with specific sequences of nucleotides .These are the main goals of DNA barcoding which can be achieved by ecologist, environmental scientist, biologist and molecular biologists.

References

Baker T, Pennington RT, Dexter KG, Fine PVA, Fortune Hopkins H, Honorio EN, Huamantupa I, Klitgård BB, Lewis G, de Lima HC, Ashton P, Baraloto C, Davies S, Donoghue MJ, Kaye M, Kress WJ, Lehmann C, Monteagudo A, Phillips OL, Vasquez R. 2017. Maximising synergy among tropical plant systematists, ecologists and evolutionary biologists. Trends in Ecology and Evolution **32,** 258-267.

Baraloto C, Hardy OJ, Paine CET, Dexter KG, Cruaud C, Dunning LT, Gonzalez M, Molino J, Sabatier D, Savolainen V, Chave J. 2012. Using functional traits and phylogenetic trees to examine the assembly of tropical tree communities. Journal of Ecology **100,** 690-701.

Chase MW, Salamin N, Wilkinson M, Dunwell JM, Kesanakurthi RP, Haider N, Savolainen V. 2005. Land plants and DNA barcodes: Short term and long term goals. Philosophical Transactions of the Royal Society B Biological Sciences **360,** 1889-1895.

Erickson DL, Jones FA, Swenson NG, Pei N, Bourg N, Chen W, Davies SJ, Ge X, Hao Z, Howe RW, Huang CL, Larson A, Lum S, Lutz JA, Ma K, Meegaskumbura M, Mi X, Parker JD, Fang Sun I, Wright J, Wolf AT, Ye W, Xing D, Zimmerman JK, Kress WJ. 2014. Comparative evolutionary diversity and phylogenetic structure across multiple forest dynamics plots: A megaphylogeny approach. Frontiers in Genetics **5,** 358.

Hebert PDN, Penton EH, Burns JM, Janzen DH, Hallwachs W. 2004. Ten species in one: DNA barcoding reveals cryptic species in the neotropical skipper butterfly *Astraptes fulgerator*. Proceedings of the National Academy of Sciences USA **101,** 14812-14817.

Kress WJ, Erickson DL. 2008. DNA barcoding: A windfall for tropical biology. Biotropica **40,** 405-408.

Kress WJ, Lopez IC, Erickson DL. 2012. Generating plant DNA barcodes for trees in long term forest dynamics plots. In: WJ Kress, DL Erickson eds. DNA barcodes: Methods and protocols. New York: Humana Press, Springer Science Publishing Media, LLC 441-458.

Naeem M, Hayat M, Qamar AS, Mehmood T, Munir A, Ahmad G, Azmi UR, Faryad MA, Talib MZ, Irfan M, Hussain A, Hayder MA, Ghani U, Mehmood F. 2019. Risk factors, genetic mutations and prevention of breast cancer. Int. J. Biosci. 14(4), 492-496.

Shapcott A, Forster PI, Guymer GP, McDonald WJF, Faith DP, Erickson DL, Kress WJ. 2015. Mapping biodiversity and setting conservation priorities for SE Queensland's rainforests using DNA barcoding. PLoS ONE **10,** e0122164.

Swenson NG. 2012. Phylogenetic analyses of ecological communities using DNA barcode data. In: WJ Kress, DL Erickson eds. DNA barcodes: Methods and protocols. New York: Humana Press, Springer Science Publishing Media, LLC 409-419.

Swenson NG. 2013. The assembly of tropical tree communities the advances and shortcomings of phylogenetic and functional trait analyses. Ecography **36,** 264-276.

Valentini A, Pompanon F, Taberlet P. 2009. DNA barcoding for ecologists. Trends in Ecology and Evolution **24,** 110-117.

Webb CO, Donoghue MJ. 2005. Phylomatic: Tree assembly for applied phylogenetics. Molecular Ecology Notes **5,** 181-183.